DOCUMENT RESUME

ED 462 955 IR 021 114

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TITLE Current Practice in Designing Training for Complex Skills: Implications for Design and Evaluation of ADAPT[IT].

PUB DATE 2001-11-00

NOTE 10p.; In: ED-MEDIA 01 World Conference on Educational Multimedia, Hypermedia, & World Conference on Educational Telecommunications. Proceedings (13th, Tampere, Finland, June 25-30, 2001).

PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS Computer Oriented Programs; Educational Technology; Evaluation Methods; Foreign Countries; Information Technology; *Instructional Design; *Instructional Materials; Needs Assessment; Training

IDENTIFIERS Europe

ABSTRACT

ADAPT[IT] (Advanced Design Approach for Personalized Training-Interactive Tools is a European project coordinated by the Dutch National Aerospace Laboratory. The aim of ADAPT[IT] is to create and validate an effective training design methodology, based on cognitive science and leading to the integration of advanced technologies, so that the training community can better meet the many challenges of the information society of the 21st century. The effort falls within the European Commission's Information Society Technologies program. ADAPT[IT] is developing a personalized training design methodology, providing associated design tools for the efficient realization of that methodology, and validating the methodology in different training domains. The 3-year project began in February 2000, with an estimated total of 181 person-months required for completion. The effort is broken into these 9 work packages: project management; design preparation; design of the ADAPT method; development of the ADAPT tools; using ADAPT: design process evaluation; using ADAPT: design product evaluation; ADAPT[IT] revisions; standardization; and integration, dissemination, exploitation. An extensive needs assessment phase has been completed. The aim of this effort was to explore current practice in instructional design and associated with that, the needs of the training designers in order to improve their project and its products. This paper reports the needs assessment procedures and outcomes informing how they guide the efforts within the project. (Contains 16 references.) (AEF)

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Current Practice in Designing Training for Complex Skills: Implications for Design and Evaluation of ADAPT^{IT}

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REFERENCE: Eseryel, D., Schuver-van Blanken, M. J., & Spector, J. M. (2001). Current practice in designing training for complex skills: Implications for design and evaluation of ADAPT^{IT}. In C. Montgomerie & J. Vitelli (Eds.), *Proceedings of ED-MEDIA 2001: World Conference on Educational Multimedia, Hypermedia, & Telecommunications*, June 25-30, (pp. 474-479). Tampere, Finland: Association for the Advancement of Computing in Education.

Abstract: ADAPT^{IT} is a European project within the Information Society Technologies programme that is providing design methods and tools to guide training designers according to the latest cognitive science and standardization principles. An extensive needs assessment phase has been completed. The aim of this effort was to explore current practice in instructional design and associated with that, the needs of the training designers in order to improve their practice and to insure that real world needs will be addressed in the project and its products. This paper reports the needs assessment procedures and outcomes informing how they guide the efforts within the project.

Introduction

Advanced Design Approach for Personalised Training- Interactive Tools (ADAPT^{IT}) is a European project coordinated by the Dutch National Aerospace Laboratory (NLR). The aim of ADAPT^{IT} is to create and validate an effective training design methodology, based on cognitive

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science and leading to the integration of advanced technologies, so that the training community can better meet the many challenges of the information society of the 21st century. The effort falls with the European Commission's Information Society Technologies programme (IST; see http://www.cordis.lu/ist/) and includes as partners: National Aerospace Laboratory, the Open University of the Netherlands, the University of Bergen, SevenMountains Software, EuroControl, the Swedish Air Traffic Control Academy, and Piaggio Aerospace.

ADAPT^{IT} is developing a personalised training design methodology, providing associated design tools for the efficient realisation of that methodology, and validating the methodology in different training domains. The three-year project began in February 2000, with an estimated total of 181 person-months required for completion. The effort is broken into these 9 work packages:

1. Project management
2. Design preparation
3. Design of the ADAPT method
4. Development of the ADAPT tools
5. Using ADAPT: Design process evaluation
6. Using ADAPT: Design product evaluation
7. ADAPT^{IT} revisions
8. Standardisation
9. Integration, dissemination, exploitation

The aviation industry is targeted for this research and development effort as it is a key industry that is faced with difficult training problems and complexity of skills for which the design method is intended. Current challenges for aviation training relate to the increasing complexity of dynamic task environments, increasing time constraints, and increasing demands for cognitive and information-managing tasks. As technology takes over or automates many basic tasks and adds functionalities to operational systems, the result is that more demand is placed on humans to perform higher level and supervisory tasks. The problems within aviation training are exemplary of highly complex and automated task environments that require flexible skills and are likely to forecast training problems in other professional domains. Two quite different training areas within the aviation industry (air traffic control and aircraft maintenance) are involved so as to insure generalisability of the methodology and the tool to other subject areas and industries (see Eseryel & Spector, 2000 for more details).

Project partners are currently collaborating on designing the ADAPT methodology and associated tools (work package 3). The early literature review and training requirements analysis indicated that the most appropriate and relevant methodology was the four-component instructional design (4C/ID) model (van Merriënboer, 1997). In developing ADAPT methodology, the 4C/ID model will be: (1) extended to become a personalised training approach; and (2) tailored to meet the needs of actual designers or design teams in a variety of training domains, economical sectors, and company sizes. In order to achieve the latter, current practice in designing training for complex cognitive skills had to be identified. The project team realised this through three different data sources. First, the literature on training designers' needs was reviewed. Then, in order to better understand the instructional design practice of our target

group, questionnaires and extensive interviews were conducted with training designers in the aviation industry and in other business and industry sectors across Europe that involved training of complex skills (work package 2). In this paper, the findings of this needs assessment phase are presented. The next section contains a review of the literature on current practice in instructional design together with the findings of the interviews and questionnaires conducted during the needs assessment phase. The paper concludes with implications of the needs assessment phase for the design and validation of ADAPT methodology and ADAPT^{IT} instructional design tool.

Current Instructional Design Practice & Needs

Literature review on current instructional design (ID) practice reveals that ID practice is significantly different from what is prescribed in ID models (Holcomb, Wedman & Tessmer, 1996; Klimczak & Wedman, 1997; Loughner & Moller, 1998; Pieters & Bergman, 1995; Rowland, 1992; Seels & Glasgow, 1991; Visscher-Voerman, 1999; Wedman & Tessmer, 1993; Zemke, 1985). The most prominent activity prescribed in ID models, but rarely completely performed by practitioners, is task analysis. Other instructional design activities that are often omitted or only partially performed are assessment of entry skills or characteristics, and the pilot testing of programs prior to implementation. Studies that investigated expert instructional design performance also revealed important differences between the activities expert designers perform and what is prescribed in ID models (Maistre, 1998; Perez & Emery, 1995; Rowland, 1992).

In the literature, several reasons have been identified that might explain the lack of proper application of ID models. These reasons can be divided into reasons that are either internal or are external to ID (Gros, Elen, Kerres, van Merriënboer & Spector, 1997). Internal reasons refer to insufficiencies of current ID models that might be responsible for their limited usefulness. These are threefold: (1) the models are not sensitive to the design context; (2) the models do not match with the way designers work in practice; and, (3) there are many ID models and they are hard to differentiate. On the other hand, external reasons refer to deficiencies in the application of existing ID models. These can be attributed to the lack of professionalism in the ID field and lack of necessary design skills and knowledge. In order to improve instructional design practice, ID tools have been developed to fill this gap (Spector, Polson, & Muraida, 1993). However, what have been missing in the area of automated instructional design are sufficiently elaborated design models with associated guidance and frameworks that are appropriate for the design of training for complex cognitive skills. The ADAPT^{IT} project is intended to fill this gap with the set of methods and tools available to instructional designers. For the project to be successful, it is important for the design team to know the needs of the probable users of system. Therefore, training designer's need across Europe had to be identified as a next step of needs assessment phase in the project.

Next to the more global literature review, designers' needs were identified by means of questionnaires and interviews (see ADAPT^{IT}, 2000). The target group was training designers in Europe who are actively involved in the design of training for complex domains. Training designer needs are defined as the requirements that have to be met in order to change and improve current design practice. These requirements refer primarily to instructional design practitioners' perceived needs for support to use and apply instructional design theories and models.

The questionnaires were sent to respondents in different sectors: education, information and communications technology, transportation, business, and manufacturing. The response rate was low (8% of in total 150 questionnaires), which is attributed to the length of the questionnaires and the time required to fill them out. Although this may be counted a weakness, the questionnaires provided in-depth information to make informed judgments about the target group. Besides, the questionnaires were backed up with extensive interviews in order to gather more detailed information on current training design practices, the problems that are encountered and the desired support and specific needs during the training design process.

Each interview took around three hours. In total, 10 interviews were conducted involving: 1 naval college, 3 air traffic control centres, 2 aircraft maintenance organisations, 1 telecommunications organisation, 1 information technology company, 1 training consultancy organisation and 1 distance education company. Unlike the questionnaires that produced data in one format, the more in-depth interviews were intended to provide detailed and rich information about company design practices. As interviewee background and companies differ substantially, the interviews were loosely structured in the sense that questions were open and no pre-defined answer categories were supplied. This was intended to stimulate the interviewer towards more natural, personal and company-specific responses. Some structure was provided for the interviewer by a list of questions and themes to be addressed. The interviews not only yielded more detailed information, but, more importantly, they yielded an impression or feeling of current design practice, which did not emerge from the questionnaires.

The emphasis during these data gathering efforts was on the difference between current and ideal training design practice, on the problems experienced during the design process, and on the ideal characteristics of an instructional design tool. Table 1 provides an overview of the most important characteristics of current design practice that emerged from the results of the questionnaires and the interviews. The literature review, the questionnaire survey and the interviews have also resulted in training designer's needs for ADAPT^{IT}. The most important designer needs for ADAPT^{IT} are summarised in table 2.

Current instructional design practice and the training designer's needs emerged as an outcome of needs assessment phase strongly suggests the demand for an integrated ID method-tool combination by business and industry. ADAPT^{IT} project aims at bridging the gap between complex training problems and new technological possibilities by developing and validating a training design framework to guide the use of state-of-the-art cognitive approaches within advanced training systems. In order for the project to be successful, the design effort is guided by the outcomes of the needs assessment phase as design requirements (work package 3). These outcomes will also be utilized for evaluating the final outcomes of the products (work packages 5 & 6). The next section discusses the implications of the findings of needs assessment for the design and evaluation of ADAPT^{IT}.

Category	*Current design practice*
Training designer background	• A majority of training designers have an operational background and became designers after having worked in the operational field. They are not fully occupied with designing training as it is often combined with roles as instructor or training manager.
Training design process	• Current training design practice does not follow a standard Instructional Systems Design model. Activities are carried out selectively and often partly and are often characterised by implicit and intuitive methods. • The analysis phase is not carried out explicitly and in detail, mostly due to constraints involving time and resources. • The design phase appears often to be combined with the development phase, and often happens implicitly as part of the development and implementation of training. Specific instructional design models or principles are rarely explicitly used by designers with an operational background. However, many basic ideas and some instructional design principles seem to be intuitively understood and used. • A detailed and systematic evaluation does not occur and is for a large part based on subjective data. The distinction between formative and summative evaluation is not found. Formative evaluation seems to take place informally. Summative evaluation mainly focuses on short-term evaluation.
Organisational aspects	• In general, training is not designed in formally structured design teams. The most important actors in a team are subject matter experts and instructors, who typically design the training. Collaborative design does not seem to take place explicitly.

Table 1: *Characteristics of current design practice that emerged from the questionnaires and the interviews.*

Implications for Design and Evaluation of ADAPT^{IT}

The training designers' needs that form one of the guiding principles for ADAPT^{IT} is originating from the fact that respondents questioned the merit of a tool as opposed to current design practice. Respondents were justifiably concerned with regard to a tool constraining the application of their current working methods and knowledge and skills. As instructional designers vary along the dimension from novices to experts with corresponding cognitive differences in the way they approach their tasks the system should be flexible enough (i.e., weak approach to design) to handle different sequence of uses and the messages should be tailored to the designer's level of expertise. ADAPT^{IT} should therefore be set up in such a way that all designers, including designers without a specific educational background, should quickly become aware of and convinced of the additional value of ADAPT^{IT}. The system should be flexible enough to allow advanced users integrate their own design practise, knowledge and skills. Inexperienced designers may require (ask for) more support in the process of structuring

Category	*Training Designer's Needs*
Training designer background	1. Target at training designers with an operational background but do not exclude those designers with an educational background; 2. Use non-academic instructional design language, fitting the main target group of designers with an operational background.
Training design process	1. Support an explicit, structured and systematic design process, especially for the analysis, design and evaluation phases; 2. Take into account that current design practice is often characterised by implicit and intuitive methods. Support the designers in the change in design process (e.g. by allowing some intermediate ways of design focusing on the vital aspects of training design); 3. Convince the users to adapt their working practice (e.g. by explaining the added value of the different design steps and explaining the steps by means of practical worked-out examples); 4. Provide pragmatic, practical useful methods that yield quick results and can be easily used to produce at least a minimal required training design (see also 2).
Organisational aspects	1. Address the relational aspects during the training design process (setting up teams, involving users, methods for teamwork, collaborative design, communication etc.).
Design tool characteristics	1. Provide practical worked-out examples; 2. Provide support/guidance in applying instructional design principles; 3. Link together the different training design products; 4. Provide methods for file management and version control; 5. Make information easily re-usable and retrievable; 6. Allow different degrees of freedom (e.g. from structured to non-sequential design); 7. Increased efficiency: design training more quickly; 8. Increased effectiveness: design better training.

Table 2: *Some of the training designer's needs identified by the questionnaire survey and the interviews.*

their analysis and design results. For this kind of audience, the use of non-academic language is of utmost importance. In addition, a number of design supports will be integrated in the system:

1. The ADAPT methodology handbook that will describe how to analyse complex cognitive skills and how to design training for those skill along with worked-out examples.
2. The CORE software tool that will support the use of the ADAPT methodology by allowing storing and viewing analysis and design results and by producing a blueprint

for training in such format that it can be further worked out with third party authoring software.

3. An online help system and manuals, describing functionality and procedures for using the ADAPT tool with implementation examples.
4. An expert design and standards advisor.
5. An evaluation software (EVAL) to support formative and summative evaluation of the training.
6. Familiarisation training for the trainers to teach to apply the ADAPT method and tool supported by a web-based online tutorial.

The ADAPT system should have an impact on training design practice. Therefore, the method-tool combination is aimed at ensuring effective training design for complex cognitive skill embodying a validated training design methodology for personalized training that is based on the latest developments in the cognitive science. The tool itself also aims at more efficient training design by integrating several technologies, such as the re-usability of intermediate design products, version control, and support for adapting training design to changes in the external constraints (e.g., training time, characteristics of the target trainee, etc.). Furthermore, the system will be customisable to user preferences and allow collaborative design and rapid prototyping.

The project recognizes evaluation for its critical role it plays throughout the lifetime of the system. Functional specifications arising from the needs assessment phase and the aims of the system forms the basis of the evaluation plan guiding the design, production and revision of the full-scale system. The evaluation and validation activities in the project are twofold: (1) evaluation of the training design process; (2) validation of effectiveness of training design products. Integrated in the former, the instructional design modelling approach will also provide the means to pinpoint problems in instructional design guidance that the system provides. In both studies, the impact of the ADAPT^{IT} system will be compared with the traditional practices. The project partners from aircraft maintenance and air traffic control will be involved in these studies to insure the generalisability of the methods and the tools to other domains. The user-centred process adopted for this project insures that the real world needs will be addressed in the project and its products.

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Acknowledgements

The work presented in this paper is the outcome of the collaborative efforts of ADAPT^{IT} project partners (see http://fjellbekk.eist.uib.no:2008/adaptit/) co-ordinated by J. van der Pal at the Dutch National Aerospace Laboratory NLR, pal@nlr.nl.

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